(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 November 2002 (14.11.2002)

PCT

(10) International Publication Number
WO 02/091516 A1

(51) International Patent Classification[7]: H01Q 1/24, 1/32

(21) International Application Number: PCT/FI02/00392

(22) International Filing Date: 8 May 2002 (08.05.2002)

(25) Filing Language: Finnish

(26) Publication Language: English

(30) Priority Data:
20010957 8 May 2001 (08.05.2001) FI

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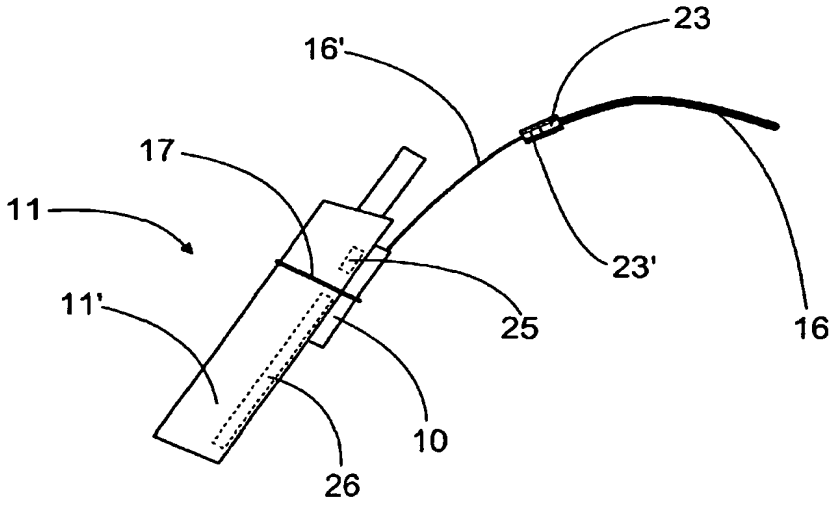
(81) Designated States *(national)*: AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ANTENNA ADAPTER FOR AN RF-DEVICE



(57) Abstract: The invention relates to an antenna adapter for a RF-device. The antenna adapter (10) is intended to be connected, by means of a lead (16) containing a pilot core (22), to an auxiliary antenna (15) arranged in the signal field. In addition, it is arranged to be installed in connection with a RF-device (11), for transferring a signal inductively/as electromagnetic radiation from the auxiliary antenna (15) to the RF-device (11). The antenna adapter (10) includes a tuning circuit roughly tuned to the specific frequency range of a signal, the oscillator (19) contained in which tuning circuit is arranged on a flat surface. The oscillator (19) is arranged as a spiral (19'), to the centre of which the pilot core (22) is connected. In addition, an earth base (20) is arranged on the flat surface, at essentially the same level as the said spiral (19').

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ANTENNA ADAPTER FOR A RF-DEVICE

The present invention relates to an antenna adapter for a RF-device, which antenna adapter is intended to be connected, by means of a lead containing a pilot core, to an auxiliary antenna arranged in the signal field, and which is arranged to be installed in connection with a RF-device, for transferring a signal inductively/as electromagnetic radiation from the auxiliary antenna to the RF-device, and which includes a tuning circuit roughly tuned to the specific frequency range of a signal, the oscillator contained in which tuning circuit being arranged on a flat surface.

Auxiliary antennae are used particularly with mobile telephones, if the signal of base stations in the area is too weak, or the path of the signal to the mobile telephone is obstructed, for example, by buildings. Model-specific auxiliary antennae are available for most mobile telephones, which, however, are impossible to be used with mobile telephones of a different make or model. Auxiliary antennae have also been developed, which can be connected to a universal antenna adapter to be set around the antenna of a mobile telephone. In the antenna adapter in question, the signal coming from the auxiliary antenna is transmitted inductively to the antenna of the mobile telephone and vice versa. Despite being universal, the operation of the said antenna adapter varies when connected to antennae of different lengths. In addition, there are nowadays mobile telephones without an external antenna. In such cases, it is practically impossible to install a known antenna adapter on the mobile telephone, while even its operation is uncertain.

GB patent publication number 2266997 discloses an antenna adapter that can be detachably mounted on a mobile telephone. The oscillator forming part of the antenna adapter is fitted close to the antenna of the mobile telephone. However, the

oscillator in question must be installed very precisely and close to the antenna of the mobile telephone. This is because the oscillator oscillates in every direction and is also low-powered. In addition, the mounting of the antenna adapter requires a counterpart that is permanently attached to the mobile telephone.

The invention is intended to create a new type of antenna adapter for a RF-device, which is smaller and more powerful than before, but which will fit different kinds of RF-device. The characteristic features of the present invention are stated in the accompanying Claims. In the antenna adapter according to the invention, the tuning circuit is given a flat shape, so that the antenna adapter is particularly thin. In addition, by shaping the oscillator of the tuning circuit, the antenna adapter has been made small. At the same time, it is simple to orientate the output of the oscillator. Despite its smallness, the antenna adapter can be tuned to signal frequency ranges especially suitable for mobile telephone operation. Unconventionally, the antenna adapter is placed against the mobile telephone, so that it is easier to attach and it is suitable for all mobile telephones, even small ones without an external antenna. In addition, unlike auxiliary antennae that are connected galvanically, the inductive connection is generally not sensitive to atmospheric interference and the associated voltage peaks.

In the following, the invention is examined with reference to the accompanying drawings showing some embodiments of the invention, in which

Figure 1a shows the antenna adapter according to the invention in operation when connected to a mobile telephone,

Figure 1b shows a partial enlargement of Figure 1a,

Figure 2a shows a front view of the antenna adapter according to the invention,

Figure 2b shows a rear view of the antenna adapter of Figure 2a,

Figure 3a shows schematically a second embodiment formed from the antenna adapters according to the invention,

Figure 3b shows schematically a third embodiment formed from the antenna adapters according to the invention.

Figure 1a shows a schematic diagram of the operation of the antenna adapter according to the invention. The antenna adapter is intended for connecting an auxiliary antenna to a RF-device (Radio Frequency), such as, in this case, a mobile telephone. In the situation of Figure 1a, the signal sent by the base station 12 cannot contact the mobile telephone 11, because the mobile telephone 11 is inside a thick-walled reinforced-concrete building 13, in which there is also dense wire mesh 14 over the window. Other corresponding locations are, for example, cellars, civil-defence shelters, and machine rooms. However, it is possible to use the mobile telephone 11 with the aid of an auxiliary antenna 15, which is arranged in the signal field, for example, on the roof of the building 13. The signal is shown with an arrow. The commonest auxiliary antennae are dipole and directional antennae. Figure 1a shows a dipole antenna as the auxiliary antenna 15, which is tuned to receive the signal sent by the base station 12. In the auxiliary antenna 15, there is also a lead 16, which is connected to the antenna adapter 10. Besides buildings, vehicles are another important location for applications.

Figure 1b shows the antenna adapter 10, which is detachably attached to the mobile telephone 11. Operationally, the signal is transferred inductively/as electromagnetic radiation from the antenna adapter to the mobile telephone and vice versa. The construction of the antenna adapter is examined in greater

detail in connection with Figures 2a and 2b. Unlike in known solutions, the antenna adapter 10 is attached to the mobile telephone 11 separately from its antenna. According to the invention, the antenna adapter 10 is arranged to be mounted against the mobile telephone 11' essentially at the location of the RF-element 25 forming part of the mobile telephone 11'. There is then little radiation around the mobile telephone, as the signal is transferred over a short distance from the RF-element to the antenna adapter. A special attachment construction can be used for the attachment, or according to Figure 1b, simply a rubber band 17. A galvanic connection is unnecessary, as the signal is transferred inductively. For example, when used in a vehicle, the antenna adapter can be attached to even a simple mobile telephone holder, in which case the mobile telephone will receive a good signal when it is in the holder.

Figure 2a shows a front view of the antenna adapter 10 according to the invention. The broken line shows a possible plastic covering 18 of the antenna adapter 10. To be able to operate as a receiver and transmitter, there must be a tuning circuit containing an oscillator in the antenna adapter, the circuit being roughly tuned to the specific frequency range of a signal. Nowadays, GSM technology is in general use. The 950-MHz frequency is then used, so that the antenna adapter is tuned, for example, to the frequency range 930 - 970 MHz. While this means that the power of the tuning circuit remains slightly below its maximum, it will operate over a broad frequency range.

According to the invention, the oscillator 19 is arranged as a spiral 19' on a flat surface, which is arranged to be placed against the mobile telephone. Thus, the antenna adapter is both small and extremely thin. Further, the earth base 20 of the tuning circuit is also arranged on the flat surface, making a separate earth base unnecessary. When used with a mobile

telephone, the spiral 19' of the antenna adapter 10 is arranged to be place at the location of the RF-element 25 of the mobile telephone 11'. The signal is then transferred with the smallest possible loss.

The flat surface is, for instance, a circuit board 21, on which the spiral 19' and the earth base 20 are arranged as conductor films. Thus, the spiral and the earth base add practically no thickness to the antenna adapter. Usually, the conductor films on a circuit board are copper, but in the antenna adapter according to the invention the conductor films can be silver, or they can be silvered. The losses in the tuning circuit are then small. The shining silver surface is shown by diagonal hatching in Figure 2a. Correspondingly, the base material of the circuit board is shown by dot shading. In Figure 2b, the circuit board 21 is shown with dot shading throughout, while the outlines of the spiral and earth base can be seen through the circuit board 21. In place of a circuit board, the flat surface can be formed, for example, from a ceramic plate, a suitable technique being used to form the conductor films on its surface. According to Figures 2a and 2b, the earth base 20 and the spiral 19' are arranged on the flat surface separately from each other. They can therefore operate without interfering with each other.

The leads 16 of universal auxiliary antennae include a connector 23. Though in principle a corresponding connector could be fitted to the antenna adapter, this would easily increase the thickness of the antenna adapter. According to the figures, the connector 23' belonging to the antenna adapter 10 is actually fitted to a thin and flexible connector lead 16', at a short distance from the antenna adapter 10. Thus, the antenna adapter remains as thin as possible, while the flexibility makes the connectors easy to use and connect. The length of the connector lead varies from a few tens of centimetres to about two metres and it is further connected to

a thicker low-loss, or preferably a so-called lossless lead. In a good field, it is possible to use a suitable branching connector (Figure 3a) to connect several antenna adapters according to the invention to a single auxiliary antenna, and even to use several mobile telephones simultaneously, without them interfering with each other.

The pilot core 22 forming part of the connector lead 16' is attached precisely to the centre of the spiral 19', so that the pilot core 22 will interfere with the induction as little as possible. This can be seen especially in Figure 2b. In addition, the oscillation field of the spiral becomes aligned and precisely delimited. In practice, the oscillation field is tubular and its alignment is normal to the flat surface. In addition, the power peak of the oscillation field is in the centre of the spiral, making it easy to place the antenna adapter correctly. In addition, the conductor film forming the earth base 20 extends above the edge of the circuit board 21, so that it is easy to attach the connector lead 16' to it. The shape of the earth base can vary between different applications. However, the earth base must be separate from the spiral. In addition, the earth base must not cover the flat surface opposite to the spiral, nor must it entirely enclose the spiral.

According to the invention, the tuning circuit also includes an open length of signal lead 22 before the spiral 19', the length of which is arranged as desired to tune the tuning circuit. In other words, the tuning circuit is tuned by altering the open length, so that the length varies in different applications. This is shown by the signal lead with a broken line in Figure 2b. In practice, the earth base is connected to the sheath of the coaxial cable used as a lead, the inner wire forming the pilot core.

In practice, the flat surface is arranged to be placed particularly against the rear surface of the mobile telephone. Thus, it interferes with the use of the mobile telephone as little as possible. In most mobile telephones without an external antenna, the internal antenna is in the upper part of the mobile telephone, so that the induction/radiation path is advantageously short. This further ensures the operation of the antenna adapter.

Figures 3a and 3b show embodiments formed from antenna adapters according to the invention. At the left-hand side of Figure 3a, three antenna adapters 10 are connected to a single auxiliary antenna 15. For this purpose, means 27 for connecting more than one antenna adapter to a single lead 16 have been added to the embodiment. The same reference numbers are used for components that are functionally similar. Correspondingly, in the centre of Figure 3a, each antenna adapter 10 is connected to its own lead 16, which corresponds to the embodiment of Figure 1a. Correspondingly, at the right-hand side of Figure 3a, a band amplifier 24 is arranged in the lead 16, in order to amplify the signal coming to and/or leaving from the antenna adapter 10. This improves the operation of the RF-device. In practice, the antenna adapter acts as an independent transmitter/receiver, so that its oscillation field can be exploited, for example, as follows. In Figure 3a, the rectangle shown by the dotted line represents a panel, in which there are several operational antenna adapters according to the invention. Thus, in the area of the panel, an electromagnetic oscillation field is formed, in which a RF-device can be used. The panel can be located, for example, in a wall or ceiling.

Figure 3b shows an embodiment located in a building 13. In this case, two antenna adapters 10 are used, in the leads 16 of both of which an amplifier 24 is placed. For example, one antenna adapter is arranged to receive the signal and the other correspondingly to send it. Thus, RF-devices can be used freely

within the building. In the example shown, the antenna adapters effectively transmit the signal of the auxiliary antenna. Correspondingly, the radiation directed to the user in the embodiment of Figure 1a is less than usual, because the signal is transferred at low power from the antenna adapter to the auxiliary antenna, which then radiates. In a corresponding embodiment, it is also possible to limit the use of RF-devices, particularly in a civil-defence shelter during a crisis.

In addition to the aforementioned mobile telephone embodiment, the antenna adapter can be used with other RF-devices. For example, an antenna adapter tuned to a ULA frequency can be placed, for instance, in a picture to be hung on a wall, in which case a radio located in the room in question will receive a strong signal. The radio will then have good reception and will be easy to tune. It is preferable to use an amplifier, especially in the signal reception. When the frequency changes, the size of the oscillator also changes. Generally, as the frequency increases, the size of the antenna diminishes.

In Figures 2a and 2b, the antenna adapter 10 intended for use in connection with a mobile telephone is shown in nearly full size. The height of the antenna adapter 10 is then about 50 mm and its width is about 40 mm, but its thickness is only about 5 mm. In the embodiment in question, coaxial cable is used and the impedance of the antenna adapter set at 50 Ω. The first 70 mm of the outer cover of the coaxial cable is removed, from which the sheath is connected for a distance of 25 mm to the earth base. Correspondingly, the length of the insulated pilot core is 40 mm, which corresponds to the aforesaid open length for tuning. In addition to the open length, tuning is affected by the length of the spiral. According to the invention, the length l can be calculated from the equation,

$$l=\frac{v}{f}\times\beta$$

in which v is the velocity of the electromagnetic radiation stated in the unit Mm/s, f is the wavelength of the radiation stated in the unit MHz, and β is the coefficient of progression depending on the material. In the embodiment in question, the antenna adapter is tuned to a frequency of 950 MHz, the material of the conductor film being copper. In that case, the initial length of the spiral is obtained as

$$\frac{300}{950} \times 0{,}67 = 0{,}21m = 21cm$$

Thus, the antenna adapter according to the invention is also suitable for the smallest mobile telephones and also for those without an external antenna. Using correct shaping and dimensioning and material selection, it is possible to create an antenna adapter according to the invention, which is small in size, but nearly lossless and without interference. In addition to the regular spiral described, the shape of the spiral can also be, for example, elliptical or eccentric.

CLAIMS

1. An antenna adapter for a RF-device, which antenna adapter (10) is intended to be connected, by means of a lead (16) containing a pilot core (22), to an auxiliary antenna (15) arranged in the signal field, and which is arranged to be installed in connection with a RF-device (11), for transferring a signal inductively/as electromagnetic radiation from the auxiliary antenna (15) to the RF-device (11), and which includes a tuning circuit roughly tuned to the specific frequency range of a signal, the oscillator (19) contained in which tuning circuit being arranged on a flat surface, characterized in that the oscillator (19) is arranged as a spiral (19'), to the centre of which the pilot core (22) is connected, and, in addition, an earth base (20) is arranged on the flat surface, at essentially the same level as the said spiral (19').

2. An antenna adapter according to Claim 1, characterized in that the tuning circuit includes an open length of pilot core (22) before the spiral (19'), the length of which is arranged as desired, in order to tune the tuning circuit.

3. An antenna adapter according to Claim 1 or 2, characterized in that the earth base (20) is connected to the sheath of the coaxial cable as a lead (16), the inner conductor being the pilot core (22).

4. An antenna adapter according to any of Claims 1 - 3, characterized in that the earth base (20) and the spiral (19') are arranged on the flat surface separately from each other.

5. An antenna adapter according to any of Claims 1 - 4, characterized in that the earth base (20) and the spiral (19') are arranged on the flat surface as conductor films, which are silver or are silvered.

6. An antenna adapter according to any of Claims 1 - 5, characterized in that the lead (16) between the antenna adapter (10) and the auxiliary antenna (15) includes a connector (23), a suitable connector (23') to which being fitted to a flexible connector lead (16') at a distance from the antenna adapter (10).

7. An antenna adapter according to Claim 6, characterized in that means (27) are fitted to the connector (23) for two or more connectors (23') for connecting more than one antenna adapter (10) to a single lead (16).

8. An antenna adapter according to any of Claims 1 - 7, for use in connection with a mobile telephone (11'), which antenna adapter (10) is arranged to be detachably attached in connection with the mobile telephone (11'), for transferring a signal inductively/as electromagnetic radiation from the auxiliary antenna (15) to the mobile telephone (11') and vice versa, characterized in that the antenna adapter (10) is arranged to be set against the mobile telephone (11') at essentially the location of the RF-element (25) forming part of the mobile telephone (11').

9. An antenna adapter according to Claims 8, characterized in that the spiral (19') of the antenna adapter (10) is arranged to be placed at the location of the said RF-element (25).

10. An antenna adapter according to any of Claims 1 - 9, characterized in that an amplifier (24) is arranged in the lead (16), for amplifying the signal coming to and/or leaving from the antenna adapter (10), which amplifier (24) is preferably a broadband amplifier.

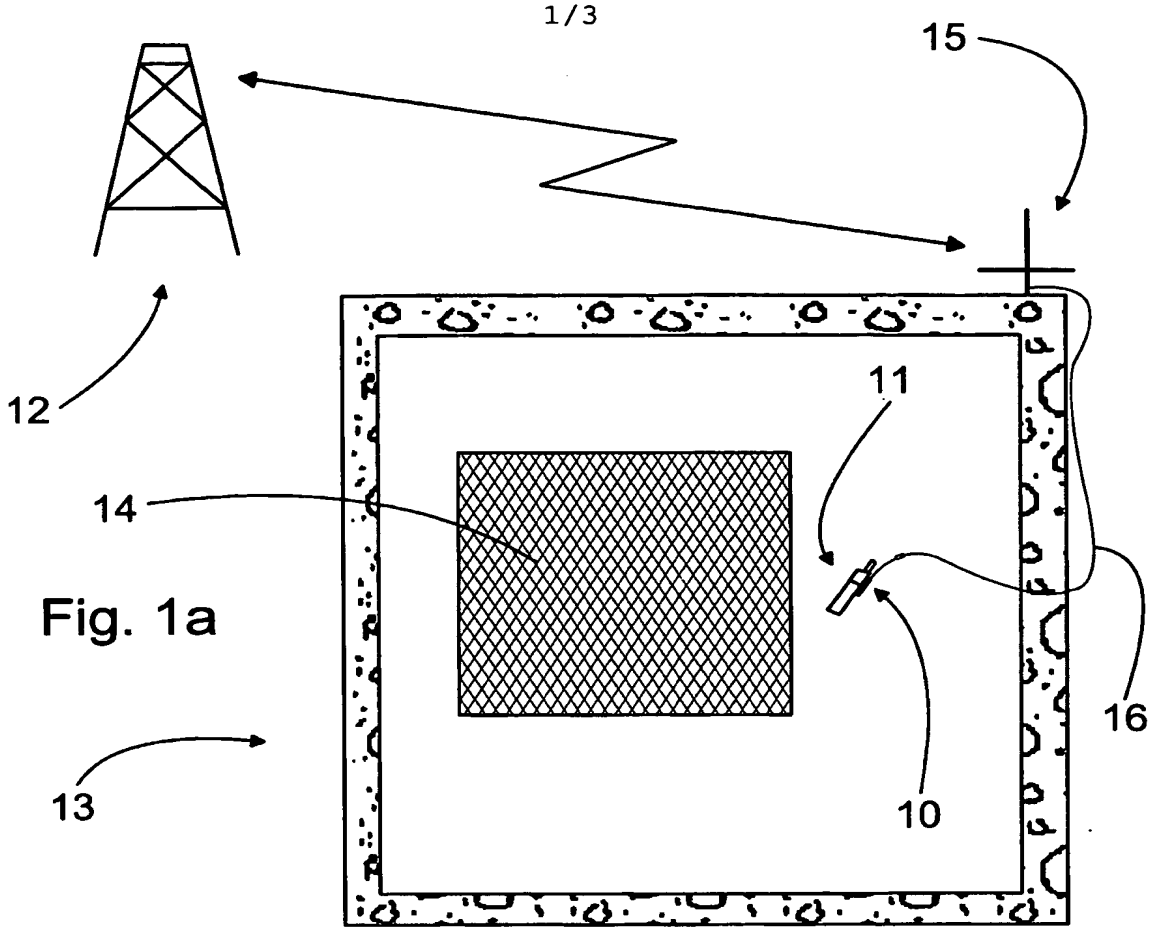

Fig. 1a

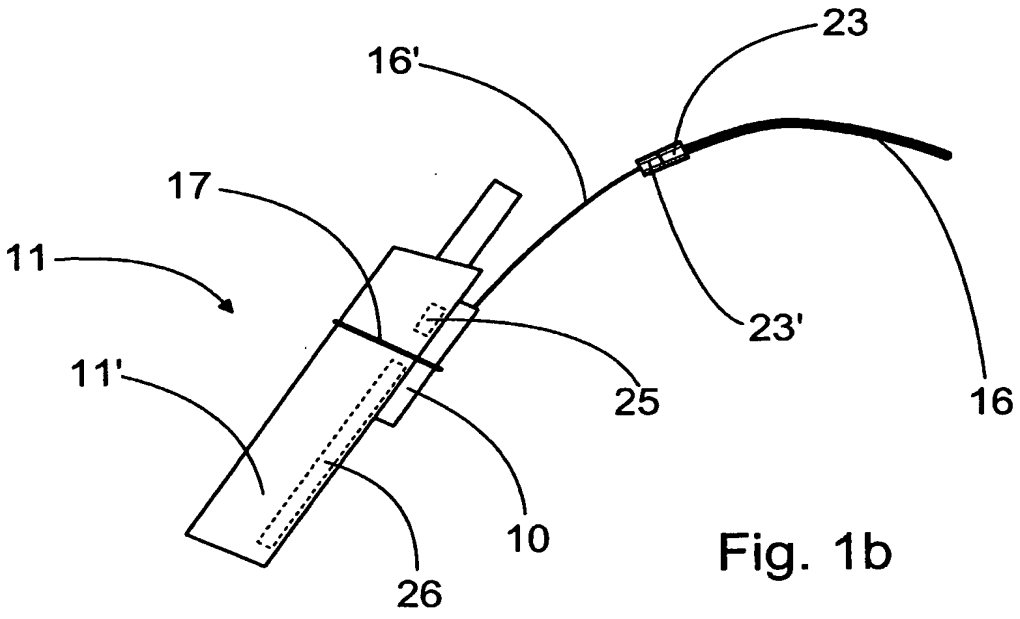

Fig. 1b

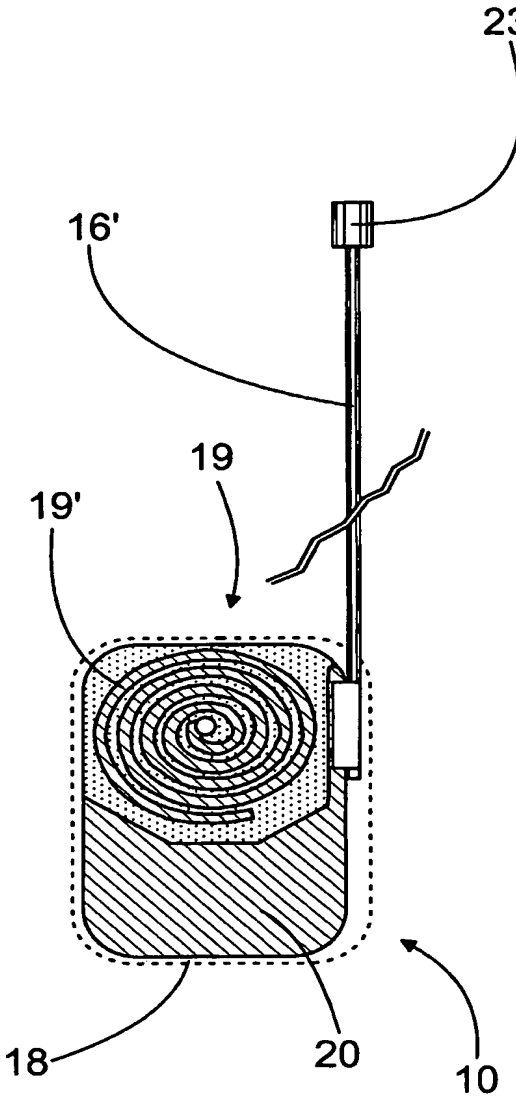

Fig. 2a

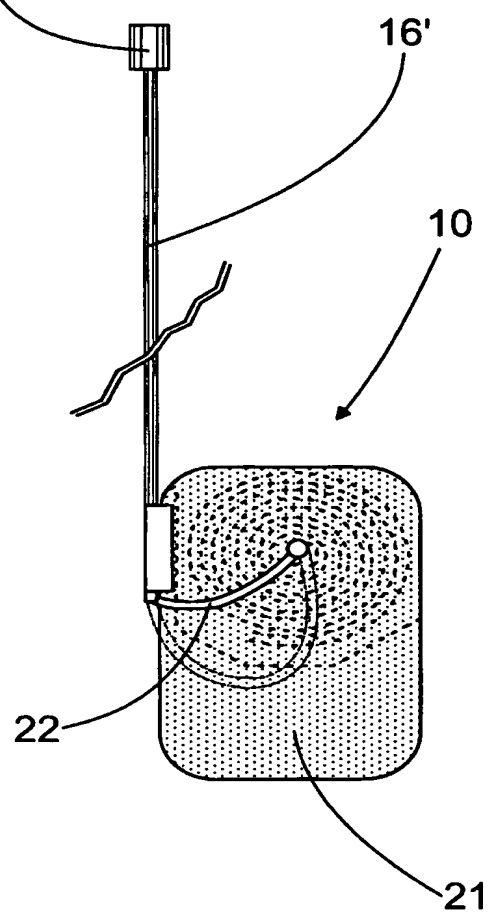

Fig. 2b

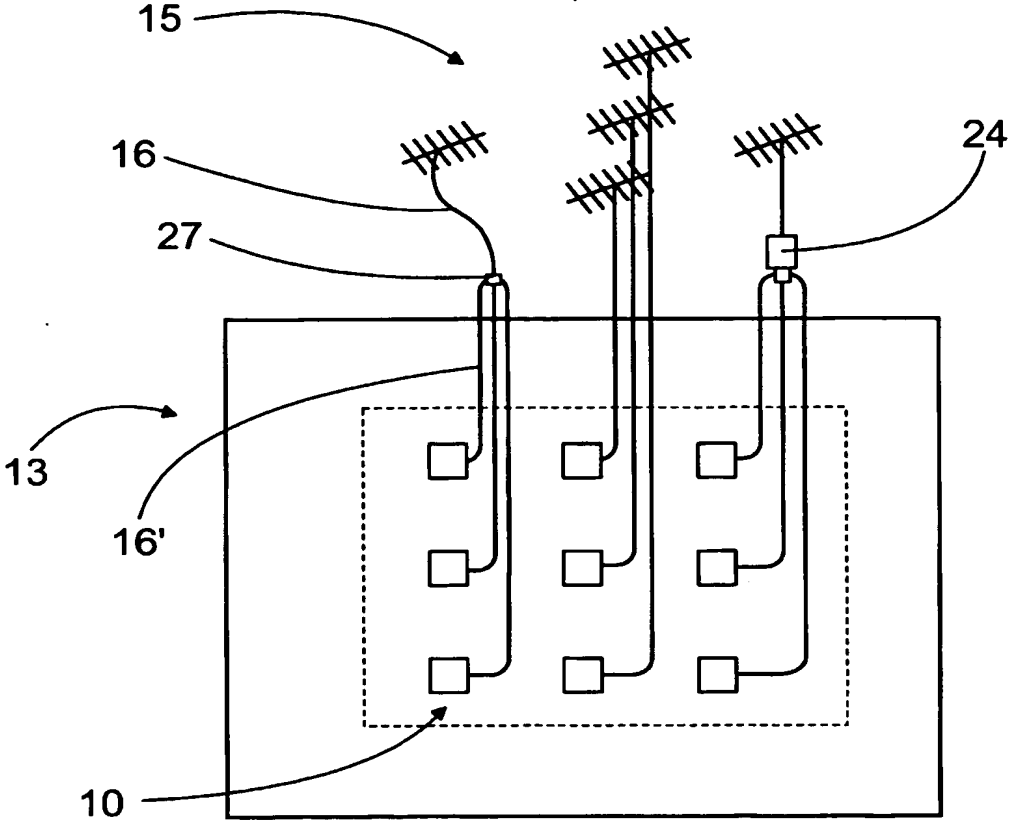

Fig. 3a

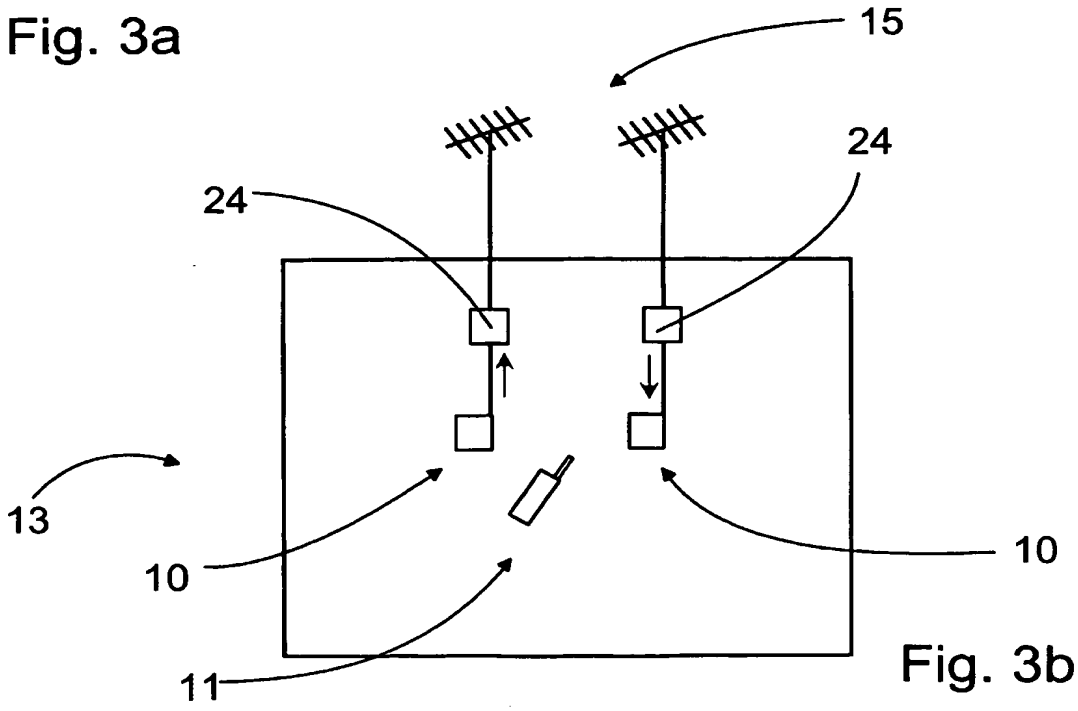

Fig. 3b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00392

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/24, H01Q 1/32
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2266997 A (LES WALLEN MANUFACTURING LTD), 17 November 1993 (17.11.93), page 3, line 12 - line 35; page 4, line 1 - line 32, figures 1-5, abstract --	1-10
A	EP 0999607 A2 (NOKIA MOBILE PHONES LTD), 10 May 2000 (10.05.00), column 2, line 39 - line 58; column 5, line 28 - line 58; column 6, line 46 - line 58, column 7, line 1 - line 5, figures 1,3-8, abstract --	1-10
A	US 4494100 A (STENGEL, R.E. ET AL.), 15 January 1985 (15.01.85), column 3, line 1 - line 68; column 4, line 1 - line 35, figures 1-3 --	1-5,9

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 August 2002	23 -08- 2002
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00392

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4431965 A (ASLAN, E.E.), 14 February 1984 (14.02.84), column 2, line 49 - line 68; column 3, line 1 - line 3; column 3, line 30 - line 64, figures 1-2, abstract -- --------	1-5,9

INTERNATIONAL SEARCH REPORT

Information on patent family members

06/07/02

International application No.
PCT/FI 02/00392

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2266997 A	17/11/93	DE 9301482 U	19/05/93
		GB 9209881 D	00/00/00
EP 0999607 A2	10/05/00	FI 106077 B	00/00/00
		FI 982389 A	05/05/00
		SE 9903871 A	05/05/00
US 4494100 A	15/01/85	NONE	
US 4431965 A	14/02/84	NONE	